

**University of Florida Data Set  
on Small-Scale Sediment Processes  
from SandyDuck'97**

## **General Experiment Information**

### ***Location***

Field Research Facility (FRF), U.S. Army Corps of Engineering, Duck, North Carolina, USA

### ***General information on FRF***

Homepage: <http://www.frf.usace.army.mil/>

### ***General information on SandyDuck'97***

Homepage: <http://www.frf.usace.army.mil/SandyDuck/SandyDuck.stm>

University of Florida SandyDuck'97 experiment homepage: <http://hanes.coastal.ufl.edu/sd97>

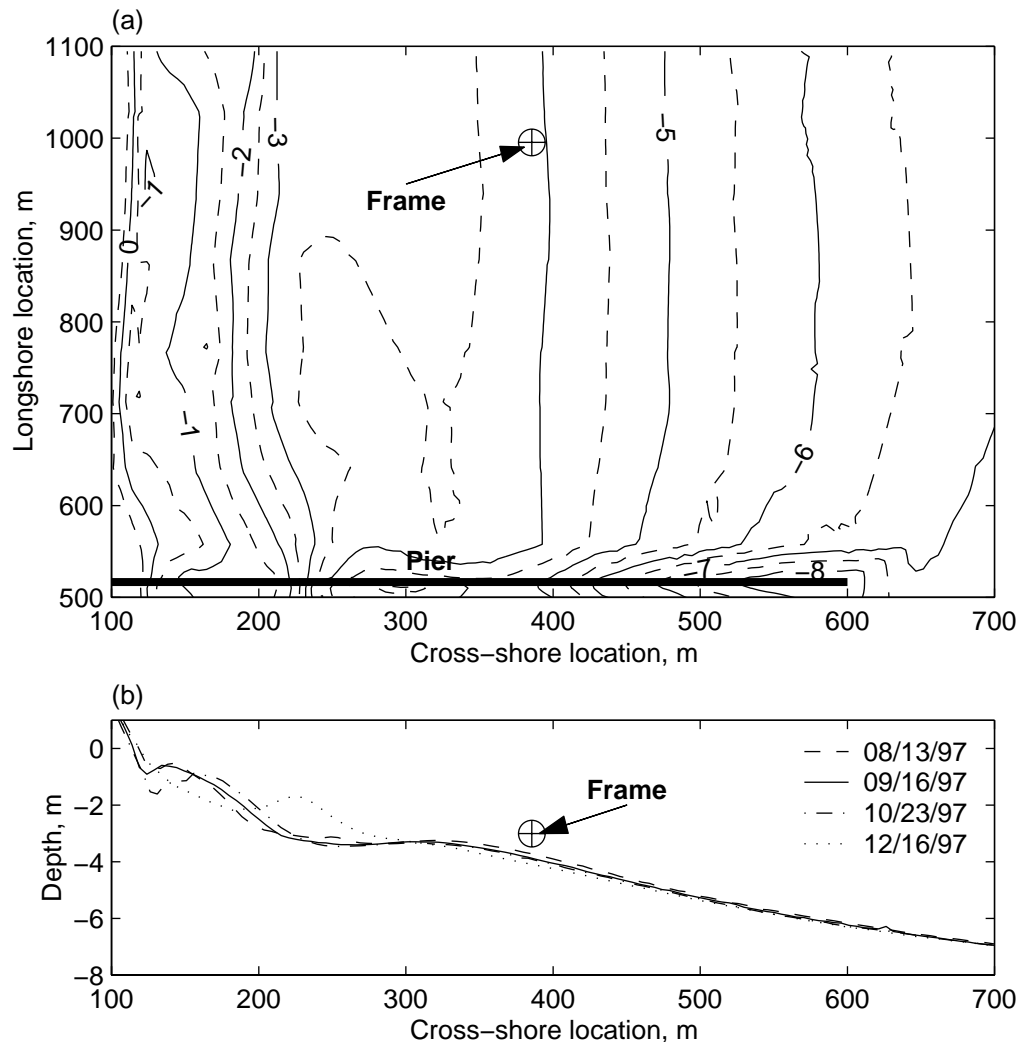
### ***FRF coordinate system***

The origin is located behind the dune near the southern boundary of the FRF property. The baseline of the system (cross-shore distance = 0) is perpendicular to the FRF pier and is aligned 20 W of true North. Elevations were measured relative to the National Geodetic Vertical Datum (NGVD) of 1929. This datum is 0.42 m above Mean Low Water (MLW).

## Description of the University of Florida's (UF) SandyDuck'97 experiment

The UF SandyDuck'97 experiment took place in Duck, NC at the Army Corps of Engineers Field Research Facility from September 11 to November 10, 1997. Measurements include hydrodynamics, bedforms, profiles of suspended sediment concentrations, video images, and some other parameters. The cumulative duration of all records is 44 days. Measurements were obtained in various wave conditions including several storm events.

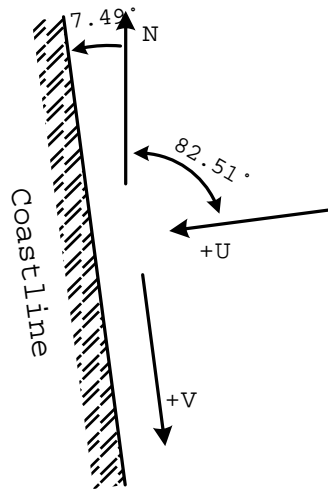
A goal-post type frame designed to minimize seabed disturbance was jetted into the seabed, and instruments were mounted on it by scuba divers, at a distance about 390 meters away from the shoreline and 1000 meters (Figure 1) along the shoreline according to the FRF coordinate system. The depth at the site location was about 3.5 meters at low tide. The beach profile with the frame position and coordinate system in  $(x,y)$ -plane are shown in Figure 2.



**Figure 1. (a) Contours of water depth on 09/16/1997 and the frame location, (b) location of frame and cross-shore beach profiles.**

The acquisition system (see Thosteson, 1997) controlled the measurement and recording scheme for several instruments with microsecond precision. Although various instruments sampled at different rates (e.g. ABS at 100 kHz), all data were appropriately averaged and recorded with one of three sampling frequencies: 1, 2, or 4 hertz. The data from each run were stored in several 34 minutes files. These data include:

- 3D velocity measurements from two ADVs (acoustic Doppler velocimeter);
- Pressure measurements;
- One-dimensional vertical profile of suspended sediment concentrations from 1.07, 2.17, and 4.80 MHz ABS (acoustic backscatter);
- Tilt, compass, and temperature data.
- Single point suspended sediment concentrations from OBS (optical backscatter system)
- Bedform measurements from a multiple transducer array (MTA).



**Figure 2. Coordinate system relative to coastline.**

One-dimensional (cross-shore) measurements of bedforms were obtained using a 64-element MTA (see Jette and Hanes, 1997). The highest temporal resolution for MTA profile data was 0.5 Hz. Slower sampling rates were sometimes used to increase the total length of the record. The MTA data were collected separately from hydrodynamic data, but were synchronized in time. Unfortunately, the bedform measurements are not available for all of the hydrodynamic data due to both sampling limitations and bio-fouling of the MTA.

In addition to the measurements described above, two sets of video observations were collected. A low light underwater video camera was mounted on the frame and viewed the area under the MTA. A rotating scanning sonar (RSS) was deployed to measure the horizontal spatial characteristics of the bedforms. Neither of these two systems obtained good quality measurements most of the time, and will not be included in the generally released data set, but these data are available upon request.

The offshore instrument setup and dimensions are shown in Figure 3. The main axis of the MTA was directed perpendicular to the shoreline and coincides with the x-direction for velocity measurements. The elevations of the instruments were estimated from ABS profiles and recalculated according to their positions relative to ABS transducers. For some data the elevation of the MTA above the seabed is known, therefore other instrument elevations can be measured more accurately.



## Data conversion description

This section describes the nature of the raw data, and the basic processing steps that lead to the converted data that is being made generally available. These steps are probably not of interest to most users but are provided for completeness. The rawest form of the data is also available upon request.

### Raw data description

There are two types of raw data files:

- 1) binary files with Single Point Instruments (SPI) and Acoustic Backscatter Sensor (ABS) data (extension \*.DAT)
- 2) binary files with Multiple Transducer Array (MTA) data (extension \*.MTA)

The data were recorded in continuous runs. Each run consists of one or several \*.DAT files and one \*.MTA file. The MTA, SPI and ABS data use synchronized clocks, and the data can therefore be synchronized. The name of each file is a standard UF naming convention that contains information about the date and time of data acquisition in the following format:

Format: dMDhmmN

d	first letter used to identify the overall experiment
M	indicates month, ex. "9" – Sep., "a" – Oct. and "b" – Nov.
D	indicates date, ex. "a" – 10th and "k" – 20th day of the month
h	indicates time, ex. "8" – 08:00 am, "b" – 11:00 am, "g" – 16:00 pm
mm	indicates minute
N	file number within a run (0, 1, ...)

### Conversion of DAT files into MAT files

**Step 1.** Convert \*.DAT files into \*.BIN files using MODMONSFMT.EXE program. Run MODMONSFMT.EXE in DOS mode or use function MODMONSFMT in Matlab.

**Step 2.** Convert \*.BIN files into \*.MAT files. Use function MONSBIN2MAT in Matlab. The resulting files in Matlab format contain the following variables:

frms1	}	voltage records from ABS
frms2		
frms3		
spmen		voltage records from 14 channels of SPI data

1 – ADV1 amplitude	9 – OBS
2 – ADV1 x-component of velocity (u1)	10 – Pressure
3 – ADV1 y-component of velocity (v1)	11 – Tilt1 (along MTA)
4 – ADV1 z-component of velocity (w1)	12 – Tilt2 (cross MTA)
5 – ADV2 amplitude	13 – Compass
6 – ADV2 x-component of velocity (u2)	14 – Temperature
7 – ADV3 y-component of velocity (v2)	
8 – ADV4 z-component of velocity (w2)	

hdr1

file header

1 – year; 2 – month; 3 – day; 4 – hour; 5 – min; 6 – sec  
 7 - sampling period in 0.01 secs (ex. 25 = 4Hz)  
 8 - number of bins in ABS profile  
 9 - number of channels (14)  
 10, 11 – undefined

**Step 3.** Combine data files of one run into one file. Use function COMBINERUN. The last digit in each file name is changed to "0". Note that each file within a run has the same variable 'hdr1'. This results in incorrect conversion of time-related variables for files with numbers (last digit in the name of file) >1 if they would be converted (Step 4) separately. For some runs the files become of enormous size and could not be converted as one file. For these runs the conversion was made separately for each file of the run and the time-related variables were corrected afterwards.

**Step 4.** Convert the variables into physical units. Use function CONVERT\_SD97 in Matlab to:

1. Get time-related variables from file header (hdr1).
2. Convert SPI data (spmen) into physical units (see "Instruments, description of variables and conversion")
3. Correct 3D velocities by applying measured tilts.
4. Remove seabed return from raw ABS data (see "ABS seabed return").
5. Converts ABS data into profiles of suspended sediment concentration using ABSolution.

There are two types of output files:

1. Files with the converted variables described in Table 1 below.
2. Files stored under a folder 'frms\_brtn\' with variables (see RMBOTTOM function and "ABS seabed return" for more details):

frms1b frms2b frms3b	}	voltage records from ABS with seabed return removed
botprofs1 botprofs2 botprofs5	}	profiles of estimated seabed returns.

**Table 1. Variables converted by CONVERT\_SD97**

Name	Units	Description
sampfreq	Hz	sampling frequency for SPI and ABS
jctime	day	time vector in Julian days starting with midnight, 01/01/1997 = 0.0
pres	m	depth from pressure sensor
<b>Velocity measurements (ADV1, ADV2)</b>		
adv1, adv2	counts	mean signal amplitude
u1, u2	m/s	cross-shore, positive toward 262.51 degrees (onshore)
v1, v2	m/s	longshore, positive toward 172.51 degrees
w1, w2	m/s	positive upward (relative to gravity)
<b>Tilts Temperature and Compass (TTC)</b>		
tilt1	deg	cross-shore (along MTA), positive counterclockwise in (u,w)-plane
tilt2	deg	longshore, positive counterclockwise in (v,w)-plane

Name	Units	Description
comp	deg	relative to true North or Magnetic north
tdegc	centigrade	water temperature
<b>OBS</b>		
obs	g/l	suspended sediment concentration from OBS sensor
<b>ABS</b>		
botbin1 botbin2 botbin5	bin number (fractional)	seabed location (see “ABS seabed return”)
con1b con2b con5b	g/l	profiles of suspended sediment concentration. Converted with ABSolution (seabed return removed).
con1 con2 con5	g/l	profiles of suspended sediment concentration. Converted with ABSolution from initial data including the seabed return.
r	m	distance from transducer

**Step 5.** Split each run into several data files of 34 minutes (2048 seconds) long. Use function SPLITDATAFILE. The endings of the names of files change according the format:

Format: dMDhmmNN  
dMDhmm      same as before  
NN      file number within a run (00, 01, ... 10, 11...); "zz" stands for shorter files (last file of the run)

**Step 6.** Calculate some statistics and time series based on converted data. Use function PROCESS\_SD97. Refer to "Instruments, description of variables and conversion" for more details.

**Table 2. Variables calculated by PROCESS\_SD97**

Name	Units	Formula	Description
salinity	pp mil		linearly interpolated value based on daily FRF visual data
<b>Vertical coordinates for ABS profiles</b>			
r	m	$(0:N-1)*binsize + r\_offset$	Vector of distances from the ABS sensor up to Nth bin
binsize	m		size of one bin based on speed of sound
r_offset	m		offset for ABS distance resulted from acquisition delay
botbin	bin number (fractional)	mode(botbin2,1)	Modal value based on a histogram with width of class interval equal to 1 bin
<b>Elevation of instruments above the seabed based on ABS measurements</b>			
h_abs	m	$botbin*binsize + r\_offset$	Modal distance from ABS2 sensor to seabed. "binsize" is based on salinity and speed of sound (approximately 7.5mm); "r_offset" is an offset (used value 0).

Name	Units	Formula	Description
h_mta	m	$h_{abs}-0.170+.0146$	Modal distance from the seabed to top of the MTA
h_pres	m	$h_{mta}+0.001$	Modal elevation of pressure sensor
h_adv1	m	$h_{mta}-0.167-.180$	Modal elevation of sampling volume of ADV1
h_adv2	m	$h_{mta}-0.230-.180$	Modal elevation of sampling volume of ADV2
h_obs	m	$h_{mta}-0.103$	Modal elevation of OBS sensor
h	m	$h=h_{pres}+\text{mean}(\text{pres})$	Mean depth
<b>Wave statistics</b>			
eta	m		Free surface elevation calculated from pressure measurements using linear theory
Hm0	m	$Hm0 = 4\sqrt{\int S_{xx} df}$	Estimated significant wave height based on a spectrum of free surface elevation
Tpeak	s		Peak period from a spectrum of free surface elevation
<b>Time-related variables</b>			
jdstart	days		start time in Julian days (jdstart=jdtime(1))
jdend	days		end time in Julian days (jdend=jdtime(end))

**Step 7.** Calculate directional spectra. Use function ADDDIRSPEC. The spectra are calculated using DIWASP toolbox for Matlab. Please, refer to <http://www.cwr.uwa.edu.au/~johnson/diwasp/diwasp.html> for more information.

**Table 3. Variables calculated by ADDDIRSPEC**

Name	Units	Description
dsdirs	deg	Vector containing the directional bins
dsfreqs	Hz	Vector containing the frequency bins
ds????	$m^2*s/deg$	Directional spectrum based on u1, v1 and pres data
ds????pd	deg	Peak wave direction, positive counterclockwise, 0 deg = offshore
ds????pf	Hz	Peak frequency
Note: "???" stands for a method used to estimate the spectrum: "EMLM" (Extended maximum likelihood method) for 1Hz data "EMEP" (Extended maximum entropy principle) for 2Hz and 4Hz data.		

### Problem files

- Files with names D272300, D272301, D272302, D272303 have a wrong header (hdr1) because of incorrect clock settings on Monster package for this run. The headers were changed to be consistent with BeachLog. New files have names correspondingly DA1K230, DA1K231, DA1K232, DA1K233 and updated header (hdr1).
- Some files produced errors while processing (PROCESS\_SD97) so they were processed separately with some different settings. Main cause of the errors was the seabed removal

algorithm when ABS data doesn't reach the seabed, so data doesn't have a seabed return. The files are D9EJ393, D9KL591, D9KL592, DAIB170, DAJA591, DAJH510, DB4L202, DB4L203.

### **Conversion of MTA files**

**Step 1.** Convert binary files \*.MTA into \*.MAT files. Use function MONSMTA2MAT. The converted variables are:

mtar1  
 mtar2  
 mtar3

} measured distances from MTA to seabed in mm including time stamps

mtar?(1,:) - redundancy bit  
 mtar?(2,:) - seconds from 0:00 of day (up to 65536)  
 mtar?(3,:) – date  
 mtar?(4:end-1,:) – measured distances in mm  
 mtar?(end,:) – no meaning  
 Note, "?" stands for 1,2,3

**Step 2.** Calculate MTA variables. Use functions MKMTA123 and MKPROFX.

**Table 4. Variables calculated by MKMTA123 and MKPROFX**

Name	Units	Formula	Description
mta123d	mm		MTA data from 64 transducers
profx	m		X-axis for MTA
XMiddle	mm	(0:31)*15	X-axis for middle part of MTA which corresponds to mta123d(17:48,:)
<b>Time-related variables</b>			
mtatime	days		time vector for MTA profiles in Julian days
deltat	sec	mtar1(2,2)-mtar1(2,1)	time step

Note, that the spikes from the variable "mta123d" were removed separately.

## Instruments, description of variables and conversion

This part contains information on the instruments deployed by UF, the conversion of data into physical units, and calibration results.

### Acoustic Doppler Velocimeter (ADV)

**Vendor** SonTek, Inc., 5MHz ADVOcean probe

**Available instruments** ADV serial #5041 (blue) – ADV1  
ADV serial #5044 (white) – ADV2

**Instruments used in SD97** ADV1, ADV2

**Measured parameters** ADV1

Parameter	Measurements	Channel	Variable	Units
amplitude	spmen(1,:)	1	adv1	
u	spmen(2,:)	2	u1	m/s
v	spmen(3,:)	3	v1	m/s
w	spmen(4,:)	4	w1	m/s

**Measured parameters** ADV2

Parameter	Measurements	Channel	Variable	Units
amplitude	spmen(5,:)	5	adv2	
u	spmen(6,:)	6	u2	m/s
v	spmen(7,:)	7	v2	m/s
w	spmen(8,:)	8	w2	m/s

**Description** Amplitude is a mean signal amplitude from the three acoustic receivers.

**Conversion** 1.  $Velocity = Range \times \frac{V_{meas} - (V_{high} + V_{low})/2}{(V_{high} - V_{low})/2}$   
2.  $Velocity = Range \times \frac{V_{meas} - V_{zero}}{(V_{pos} - V_{neg})/2}$  – used in SD97 conversion

$Range = 2.50$  m – ADV velocity range settings

$V_{meas}$  – measured analog output voltage

$V_{high} = 4096$  – maximum analog output voltage

$V_{low} = 0$  – minimum analog output voltage

$V_{zero}$  – voltage corresponding to zero velocity

$V_{pos} = 4096$  – voltage corresponding to maximum positive velocity

$V_{neg} = 0$  – voltage corresponding to maximum negative velocity

Instrument	Parameter	Vzero
ADV1	u	2022.8
	v	2026.3
	w	2023.5
ADV2	u	2028.0
	v	2025.0
	w	2020.7

- Sources:**
1. Sontek Technical Documentation on ADVOcean probe.
  2. Laboratory calibration in bucket of still water.

### **Optical Backscatterance Sensor (OBS)**

**Vendor** D&A Instruments and Engineering, model 3

**Available instruments** OBS #865 (white)

**Instrument used in SD97** OBS #865

#### **Measured parameters**

Parameter	Measurements	Channel	Variable	Units
concentration	spmen(9,:)	9	obs	g/l

**Description** Suspended sediment concentration.

**Conversion**  $Units = V_{meas} \times Gain + Offset$   
 $V_{meas}$  – measured analog output voltage

Instrument	Parameter	Gain	Offset
OBS	concentration	8.6695e-3	-1.1343

**Source** Calibration in a recirculating calibration chamber.

### **Pressure sensor**

**Vendor** TransMetrics, Inc.

**Available instruments** H1, H2, H3

**Instrument used in SD97** H1

#### **Measured parameters**

Parameter	Measurements	Channel	Variable	Units
pressure	spmen(10,:)	10	pres	m

**Conversion**  $Pressure = (V_{meas} \times Gain + Offset) \times \frac{rho_f}{rho_s}$   
 $V_{meas}$  – measured analog output voltage  
 $rho_f = 1.000 \text{ kg/m}^3$  – density of fresh water  
 $rho_s = 1.025 \text{ kg/m}^3$  – density of sea water

Instrument	Parameter	Gain	Offset
H1	pressure	0.0042744	-0.69833
H2	pressure	0.0049167	-0.62886
H3	pressure	0.0051843	-1.113943

**Source:** Laboratory calibration using still water column.

**Tilts Temperature Compass (TTC)**

Available instruments TTC1, TTC2

Instrument used in SD97 TTC2

**Measured parameters**

Parameter	Measurements	Channel	Variable	Units
tilt1	spmen(11,:)	11	tilt1	degree
tilt2	spmen(12,:)	12	tilt1	degree
compass	spmen(13,:)	13	comps	degree
temperature	spmen(14,:)	14	tdegc	centigrade

**Conversion**  $Units = V_{meas} \times Gain + Offset$  $V_{meas}$  – measured analog output voltage**Measured parameters**

Instrument	Parameter	Gain	Offset
TTC1	tilt1	0.0143	-31.0301
	tilt2	-0.0149	36.1952
	compass	0.2445	64.3204
	temperature	0.1218	-272.3
TTC2	tilt1	0.01525	-34.9497
	tilt2	-0.0146	29.421
	compass	0.24111	-23.47427
	temperature	0.121788	-272.894

**Acoustic Backscatter System (ABS)****Vendor** Centre for Environment, Fisheries and Aquaculture Science (CEFAS, formerly known as The Fisheries Laboratory)

Available instruments ABS #1, ABS #2

Instrument used in SD97 ABS #2

**Measured parameters**

Parameter	Measurements	Variable	Units
concentration	frms1	con1b	g/l
concentration	frms2	con2b	g/l
concentration	frms3	con5b	g/l

**Conversion** of ABS data was made using ABSolution program. Please, refer to Eric Thosteson PhD dissertation, and Thosteson and Hanes (1997) for more details.**Calibration parameters:**

<b>Environment variables:</b>	
Water temperature = 20 deg C	Sand density = 2650 kg/m <sup>3</sup>
Water density = 1020 kg/m <sup>3</sup>	Mean sand phi = 2.672
Speed of Sound = 1518 m/s	Sand STD phi = 0.438

<b>General parameters:</b>		
Transducer #1 – 1.07 MHz Instrument used TVG Sampled at 100kHz after a 3e-5 second delay Crystal radius = 5 mm Nearfield limit = 0.055 m Pulse width = 1.3e-5 seconds	Transducer #2 – 2.17 MHz Instrument used TVG Sampled at 100kHz after a 3e-5 second delay Crystal radius = 5 mm Nearfield limit = 0.112 m Pulse width = 1.3e-5 seconds	Transducer #3 – 4.80 MHz Instrument used TVG Sampled at 100kHz after a 3e-5 second delay Crystal radius = 5 mm Nearfield limit = 0.248 m Pulse width = 1.3e-5 seconds
<b>Number of point in profile 100:</b>		
Water attenuation = 0.02806 Sediment attenuation = 0.02868 Backscatter parameter = 0.1718 System constant = 0.048 Variable name = frms1 8192 profiles with 100 points each	Water attenuation = 0.1154 Sediment attenuation = 0.2473 Backscatter parameter = 0.7262 System constant = 0.1110 Variable name = frms2 8192 profiles with 100 points each	Water attenuation = 0.5647 Sediment attenuation = 1.153 Backscatter parameter = 2.849 System constant = 0.2730 Variable name = frms3 8192 profiles with 100 points each
<b>Number of point in profile 120:</b>		
Water attenuation = 2.806e-002 Sediment attenuation = 2.868e-002 Backscatter parameter = 1.718e-001 System constant = 4.800e-002 Variable name = frms1 4096 profiles with 120 points each	Water attenuation = 1.154e-001 Sediment attenuation = 2.473e-001 Backscatter parameter = 7.262e-001 System constant = 1.110e-001 Variable name = frms2 4096 profiles with 120 points each	Water attenuation = 5.647e-001 Sediment attenuation = 1.153e+000 Backscatter parameter = 2.849e+000 System constant = 2.730e-001 Variable name = frms3 4096 profiles with 120 points each
<b>Number of point in profile 125:</b>		
Water attenuation = 2.806e-002 Sediment attenuation = 2.868e-002 Backscatter parameter = 1.718e-001 System constant = 4.800e-002 Variable name = frms1 4096 profiles with 125 points each	Water attenuation = 1.154e-001 Sediment attenuation = 2.473e-001 Backscatter parameter = 7.262e-001 System constant = 1.110e-001 Variable name = frms2 4096 profiles with 125 points each	Water attenuation = 5.647e-001 Sediment attenuation = 1.153e+000 Backscatter parameter = 2.849e+000 System constant = 2.730e-001 Variable name = frms3 4096 profiles with 125 points each
<b>Number of point in profile 150:</b>		
Water attenuation = 2.806e-002 Sediment attenuation = 2.868e-002 Backscatter parameter = 1.718e-001 System constant = 4.800e-002 Variable name = frms1 4096 profiles with 150 points each	Water attenuation = 1.154e-001 Sediment attenuation = 2.473e-001 Backscatter parameter = 7.262e-001 System constant = 1.110e-001 Variable name = frms2 4096 profiles with 150 points each	Water attenuation = 5.647e-001 Sediment attenuation = 1.153e+000 Backscatter parameter = 2.849e+000 System constant = 2.730e-001 Variable name = frms3 4096 profiles with 150 points each

***Multiple Transducer Arrays (MTA)*****Vendor**        Seatek Inc.**Available instruments**        MTA1, MTA2, MTA3**Instrument used in SD97**        MTA1, MTA2, MTA3**Measured parameters**

<b>Parameter</b>	<b>Measurements</b>	<b>Variable</b>	<b>Units</b>
1D seabed profile	mtar1, mtar2, mtar3	mta123d	millimeters

***Micro-SeaCam 1050*****Vendor**        DeepSea Power & Light***Model 900 rotating scanning sonar system*****Vendor**        Simrad Mesotech Systems Ltd.

## LIST OF REFERENCES

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